

The Perfect Box

Discovering the volume and surface area formulas for rectangular prisms by Karyn Hodgens

This lesson plan is designed to be used with the video lesson found on the Kidnexions YouTube Channel

CCSS: 5.MD.3; 5. MD.4; 5.MD.5

TEKS: 4th grade 5C, 5D, 8C 5th grade 4G, 4H, 6A, 6B

Vocabulary:

- Area: the number of square units needed to cover the surface of a plane figure
- Net: a 2-dimensional representation of a 3-dimensional object
- Prism: the cross sections of a solid are all the same
- Rectangular prism: a solid that is made up of six rectangular faces
- Solid: having volume and surface area; a 3-dimensional object
- Volume: the amount of space something takes up

Materials:

- Inch graph paper, 8.5 x 11 and large sheets
- Tagboard/cardstock
- Glue sticks
- Scissors
- Clear tape
- Inch cubes, about 100 (students may need to share)
- Small objects larger than a golf ball and smaller than an orange, students can supply their own object

Day 1

- Share rectangular prisms and ask students to describe attributes. Ex: 6 faces, all faces are rectangles, etc.
- Students work in pairs to write a definition for rectangular prisms.
- Describe project: Students take on the role of Senior Designer at Packagings R Us. They will need to design the perfect box (rectangular prism) for an item that they will be bringing in. Their box will be “shipped” to Australia so they will need to consider the fragility of their item when designing the box and determine appropriate packing material.
- Review area of rectangles: $l \times w = a$
- Share a variety of nets: flattened cereal box, flattened soccer ball, etc. Describe ‘net’.
- Pass out inch graph paper and have students work in pairs to make a net for a 1” x 1” x 1” cube

- Ask: How would you find the surface area of this 1" x 1" x 1" cube? Be sure students describe the surface area in square inches: 6 in^2
- Ask: How would you find the volume of this 1" x 1" x 1" cube? Be sure students describe the surface area in cubic inches: 1 in^3
- Have students work in pairs to make a rectangular prism (cube) that is 2" x 2" x 2". They need to figure out the surface area and volume. They can tape the edges together leaving the top "lid" open so they can later add cubes.
- Ask: How would you find the volume of this 2" x 2" x 2" cube? If students need to, they can fill their cube with inch cubes. Be sure students describe the surface area in cubic inches: 8 in^3
- Assign pairs of students to create rectangular prisms according to the chart.
- Students need to determine the surface area and volume of their prism. Students can design their nets on the large sheets of graph paper, cut out and glue onto tagboard. Then they fold their net to make the prism.
- Collect data and fill in the chart. Students look for patterns in the data to determine the formulas for surface area and volume of rectangular prisms:
 - Surface area: $2(lh + lw + wh)$
 - Volume: $l \times w \times h$

Day 2 - Box Design

- Students receive one large sheet of inch graph paper to begin designing the net for their box. Again, remind them of the considerations:
 - Size of object
 - Fragility of object
 - Packing material
 - Efficient use of material
- Once their net has been cleared by you, they can glue it to tagboard, cut out and tape together.
- Students determine the surface area and volume of their box.
- If time: students can "decorate" their boxes.

Extension: Day 3 - Cost Analysis

- Tell students that they will be shipping 100 of their boxes to Australia. To do this, they first need to figure out how much it would cost in packaging.

Perfect Box Cost Analysis

Yippee!! Australia wants to buy 100 of your boxed items! Before you can ship, your boss wants to know how much it will cost in packaging to ship your items. Use the information below to calculate then report back to your boss the total packaging cost.

- Tagboard comes in 18" x 24" sheets. There are 100 sheets per box. Each box costs \$24.95 per box before tax.
 - Inch graph paper comes in 27" x 34" sheets. There are 50 sheets per pad. Each pad costs \$19.95 before tax.
 - Bubble wrap comes in 12" x 150' rolls and is perforated every 12". One roll costs \$16.95 before tax.
 - Tissue paper comes in 20" x 26" sheets. There are 100 sheets per package. Each package costs \$9.99 before tax.
1. How many nets can you fit on one piece of graph paper? Use a separate piece of paper to draw how your nets would look on the graph paper.
 2. Calculate how many pieces of graph paper you will need for 100 items.
 3. How many nets can you fit on one piece of tagboard? Use a separate piece of paper to draw how your nets would look on the tagboard.
 4. Calculate how many pieces of tagboard you will need for 100 items.

5. Calculate the cost of one piece of graph paper then calculate how much it would cost for 100 items.

6. Calculate the cost of one piece of tagboard then calculate how much it would cost for 100 items.

7. How much bubble wrap/tissue paper do you need per item? Calculate the cost per item. How much will you need to ship 100 items?

8. Clearly outline below the total packaging cost for shipping 100 items to Australia.